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UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 757
OFFICE OF THE SECRETARY
Contribution from the Office of Farm Management
R. L. ADAMS, Acting Chief

Washington, D. C. ▼ March 25, 1919

FARM PRACTICES IN GRAIN FARMING IN NORTH DAKOTA

By

C. M. HENNIS, Assistant Agriculturist, and
REX E. WILLARD, Agriculturist

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SUMMARY OF FACTS BROUGHT OUT.

This bulletin presents the results of over 350 records of grain production in 1912, 1913, and 1914, for 34 counties of North Dakota, together with information relating to dates of operations, time available for field work, farm organization, character of equipment, man labor, horse labor, use of machinery, amount of seed needed for various crops, thrashing, etc. In conclusion there are presented, in comparison, the costs of various items for five years prior to the war, and the costs of the same items for 1917, as found on a representative North Dakota farm.

Wheat occupies 39 per cent of the crop acreage of the farms studied in North Dakota, oats 17 per cent, and barley 14 per cent. Crops of less importance are flax, corn, rye, and potatoes.

The average yield of wheat on the farms visited in this investigation is 13.2 bushels per acre; for the State as a whole, 12.7 bushels.

The equivalent of one disking and two harrowings, in general, appears to give better results than either more working or less. Under certain conditions the disking may be omitted and the same results obtained by covering three times with the harrow.

Summer-fallowing is not generally profitable, except in the case of land foul with weeds. Comparatively few farmers follow this practice.

No apparent difference in yields is seen between spring plowing and fall plowing, but fall plowing has an advantage in giving a better distribution of labor and making it possible to sow grain earlier in the spring.

"Stubbling-in" is almost invariably unprofitable. This practice of sowing grain without plowing, after merely disking the land, tends to lower yields and to encourage the spread of weeds and other pests.

About 6.4 hours of man labor and 10.4 hours of horse labor (average for all records) are required per acre in the production of wheat. Oats, barley, and flax require a little more work per acre than wheat. Different parts of the State show wide variation in this regard.

The cost of thrashing from the stack is slightly greater than the cost of thrashing from the shock, but thrashing from the stack has advantages in labor distribution and the saving of grain.

The cost of maintaining work stock was $145 per head in 1917, as compared with an average of $105 for the five years 1911–1916. The difference is attributable to the great advance in the price of feed.

The first cost of farm machinery used on North Dakota farms was 40 per cent higher in 1917 than the average for the five years 1911–1916.

Seed wheat cost $2.28 in 1917, as compared with an average of $1.23 for the preceding five years.

AGRICULTURAL DEVELOPMENT OF THE STATE.

The first agricultural enterprise to receive attention in North Dakota was the production of stock on large ranches. The location of the headquarters of the various holdings was determined largely by the availability of water for the cattle. As the tide of settlement moved westward and as the availability of underground water became known, the ranges were encroached upon by homesteaders who took up claims in units of 160 acres. A very large part of the ranges was Government land to which the ranchers could not secure title, but they nevertheless made use of the land for grazing purposes. (Fig. 1.) The ranchers, who had preceded the homesteaders, resented the presence of the farmers, because they encroached upon the ranges, and many attempts were made to force the withdrawal of the so-called "nesters." (Fig. 2.) However, the desire for ownership of the land was so strong that practically all Government land suitable for farming purposes has now been occupied by farmers, as distin-

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NOTE.—The data in this bulletin were secured in cooperation with the North Dakota Agricultural College. Special acknowledgment is due Mr. W. E. Palmer for furnishing photographs.

guished from the ranchers, the latter being found at present only in the more inaccessible and less desirable lands. The discovery of artesian and other underground water made it possible for the newcomers to locate in almost any place where land was found desirable for tillage.

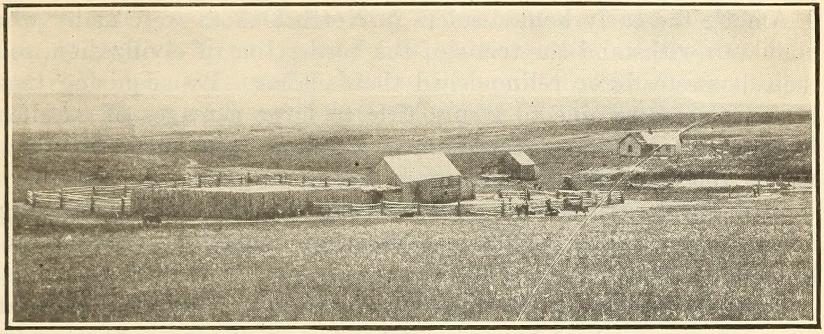

FIG. 1.—Headquarters of a North Dakota wheat ranch.

As settlement advanced, far-sighted pioneers in railroad development extended their lines, greatly facilitating the general settlement of the State. At present the trunk and branch lines make practically all farming land accessible to outside markets.

As the land was broken up, the four crops, wheat, oats, barley, and flax, were produced extensively, the last-mentioned crop being particularly adapted to freshly broken sod. Ever since farming became general in the State wheat has been the important money crop, and for many years only enough stock was kept to furnish power to till the land. However, the same experience was encountered as in other regions where a single-crop system of farming was followed, namely, the decrease in yields. This condition is very generally recognized

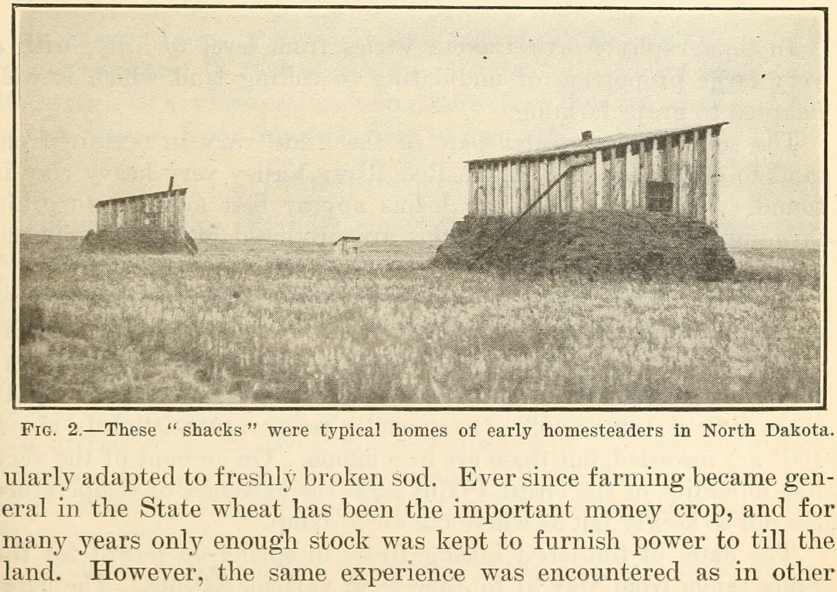

FIG. 2.—These "shacks" were typical homes of early homesteaders in North Dakota.

at present and the farmers are gradually diversifying their production. The raising of stock on the farms has increased materially, indeed, in some instances enough to overcome the decrease in crop yields. It has been found, also, that certain feed and forage crops can be produced successfully, among these being corn, alfalfa, and sweet clover.

Among the early homesteaders in North Dakota were many who, unable to withstand the trials of the border line of civilization, sold their homesteads or relinquished their claims. By acquiring these lands some were able to secure title to large acreages of excellent farming land. Others secured large acreages from the railroads, to which the Government had made extensive grants as bonuses to further the construction of railroad lines. Notable examples of large holdings are to be found at present at Casselton, Amenia, and Larimore.

With the passing of the one-crop system it is found that these extensive bonanza wheat farms are not only less and less profitable, but unsuited to the new system, and they are gradually being broken up into smaller farms and sold or leased. However, the size of the average North Dakota farm will doubtless remain comparatively large for a long time to come, and some of the holdings are still much too large to be managed efficiently under systems of diversified farming.

GENERAL CONDITIONS INFLUENCING GRAIN FARMING IN NORTH DAKOTA.

In topography North Dakota varies from level to hilly, with a very large proportion of undulating to rolling land which is well adapted to grain farming.

The soils of the greater part of the State vary in texture from sand to clay loam, and in the Red River Valley very heavy clay is found. The loams and clay loams appear best adapted to grain farming, although excellent crops are produced on the clays when the moisture is not in excess.

The climate of North Dakota is extreme. Winter temperatures ordinarily range from about freezing to 30° F. below zero, with occasional extremes of from 40° to 50° below. In summer the temperature ranges from 60° to 90° above zero, with occasional cold nights when it is as low as 40°. Occasionally temperatures slightly above 100° are recorded, but these are uncommon. On account of the very low humidity of the Great Plains area, the extremes of temperature are not so keenly felt as where the air is damp.

The dates of the latest killing frosts in spring on record for the State range from May 31 to June 28 at various stations. The dates of the earliest killing frosts in the fall range from August 6 to September 12.[1]

The rainfall of North Dakota is somewhat variable, depending upon elevation and longitude. The variation is approximately 6 inches, the precipitation in the extreme eastern part of the State being slightly over 20 inches and in the extreme west slightly less than 15 inches. From 1½ to 4 feet of snow may be expected ordinarily, though occasionally there are years with scarcely any snowfall or with as much as 8 feet. However, on account of the high, northwest prevailing winds, the amount of snow that lies on the level surface during the winter is generally small, the snow being drifted into depressions and about obstructions.

The months of May and June are the critical growing months, the amount of rainfall during these months having a marked effect on the yield of crops.

The growing season varies from about 100 to approximately 160 days, averaging 135 days, but the season in which field work is done is considerably longer. Records kept in various parts of the State show that, on the average, field work begins April 18 and closes November 6, embracing a total of 202 days. The days available for field work, after deducting Sundays, holidays, and days on which the fields are too wet, amount to 144. (See p. 9.)

THE FARM AND ITS ORGANIZATION.

In general, farms in North Dakota vary in size from a quarter section (160 acres) to four sections; a few bonanza wheat farms and stock ranches have several thousand acres each, but the average farm in the State is from three-quarters to one section in extent.

INVESTMENT PER FARM.

The selling value of land varies about 100 per cent between eastern and western North Dakota, as indicated in records from over 200 farms. The average value of farm land in the Red River Valley was $50 per acre (including buildings) in 1914. The average value of land approximately in the two rows of counties west of the Red River Valley (including Towner and Cavalier, Stutsman and Barnes, Dickey and Sargent) was $40 per acre. The average value of land east of the Missouri River, not including Williams and Mountrail Counties, but west of the above-mentioned counties, was $30 per acre, while the average value of land in the western counties of the State was $22 per acre.

Difference in the amount of rainfall is the principal cause of the extreme variation in value of land, the eastern and western parts of the State showing a difference of approximately 6 inches in annual precipitation. While the difference in average yield per acre between different parts of the State is not wide, the difference in rainfall causes a very marked increase in risk involved in crop production, which is reflected in the price of land. A less important cause is the quality of land, as that in the Red River Valley is somewhat more fertile and, being generally heavier in texture, retains moisture better than the soils of the western part of the State.

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[1] Data from United States Weather Bureau.

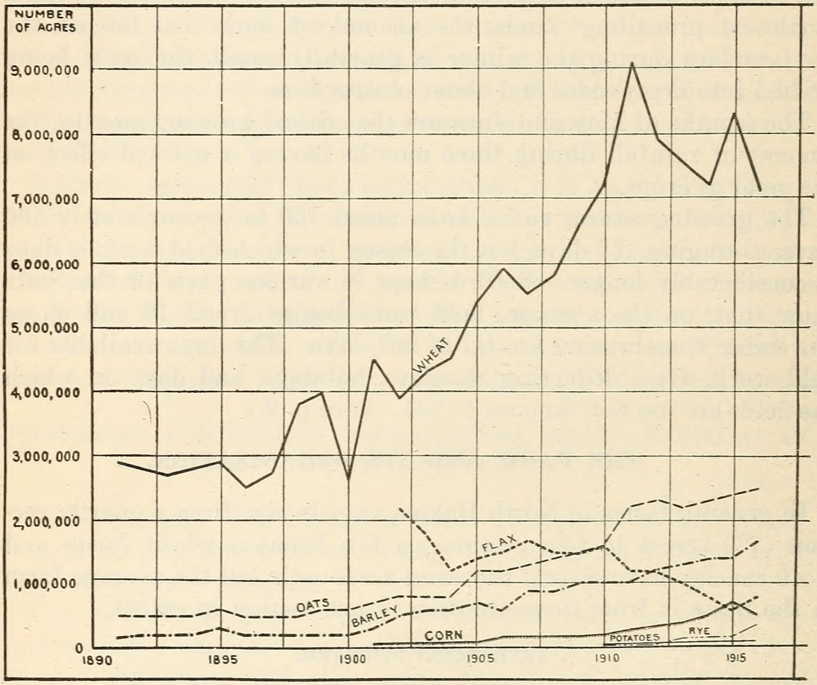

FIG. 3.—Acreage of crops (North Dakota, 1891–1916).

The value of farm buildings varies according to size of farm and decreases somewhat on farms of the same size from east to west. The latter fact is due to the earlier development of eastern North Dakota as well as to the greater certainty of production in this region. The average building investment of farms of 320 acres or under over the State is approximately $3,000. The value of buildings per farm of 321 to 640 acres averages approximately $5,000. Farms averaging 1,000 acres, and ranging from 641 to 2,560 acres, have buildings averaging $5,200 in value.

Work stock in North Dakota consists chiefly of horses, and the average value is $155 each. Farms of 640 acres utilize approximately 13 horses each. Each horse covers the equivalent of 38 acres of crops. (See page 15.)

The value of implements and machinery per farm is comparatively high. The average value of implements and machinery per farm of 640 acres, not including tractors, thrashing outfits, or automobiles, is approximately $1,800. (See p. 17.)

CROPS.

In 1917 records were obtained from representative farms in various parts of the State showing the following percentages of crop area in various crops: Wheat, 39 per cent; oats, 17 per cent; barley, 14 per cent; corn, 6 per cent; flax, 6 per cent; miscellaneous crops, 18 per cent. Tame hay and prairie hay occupied the largest areas among the miscellaneous crops; rye, millet, and alfalfa followed in order. Summer-fallow land occupied less than 3 per cent of the crop area. Pasture and waste land occupied approximately 22 per cent of the total farm area.

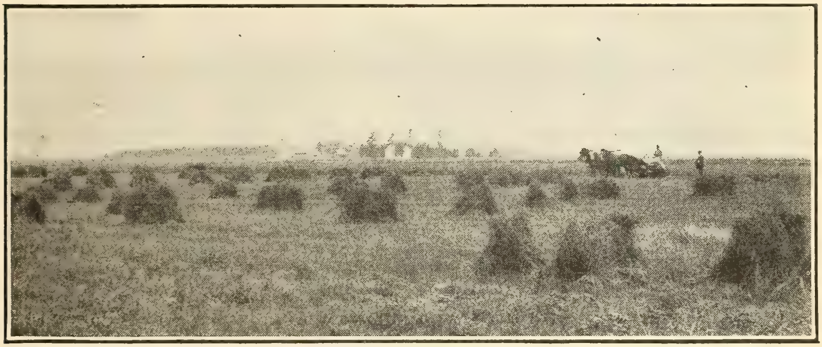

FIG. 4.—A field of oats on a characteristic Red River Valley farm.

The lines in figure 3 show the trend of acreage from year to year from 1891 to 1916. Wheat always occupied the first place, increasing from about 3,000,000 acres in 1891 to more than 9,000,000 in 1911. In 1891 flax occupied less than one-quarter million acres, but in 1902 occupied nearly two and one-quarter million acres; from that date it has diminished in importance to the present time. Flax reached its greatest importance at the time when a maximum amount of prarie sod was being broken up, as this crop is perhaps better adapted to "breaking" than any other crop produced in the region.

Oats and barley increased in acreage from 1900 to 1916, but had remained at about the same level from 1890 to 1900. These crops are utilized locally quite largely for feed, although considerable barley is sold. A good field of oats is shown in figure 4.

Corn, potatoes, and rye received little attention until after 1900, when the corn acreage increased markedly. Varieties of hardy and quick-maturing corn were developed, so that in 1915 nearly three-quarters of a million acres were growing in the State. Rye began to receive attention in 1913, and reached 350,000 acres in 1916. Potatoes increased in acreage somewhat from 1910, there being about 75,000 acres in 1915.

LIVE STOCK.

The production of live stock, particularly cattle (fig. 5), has in general increased in the State since 1860. The broad free ranges were particularly adapted to this enterprise until about 1900. Ranching is now principally confined to isolated areas in the western part of the State.

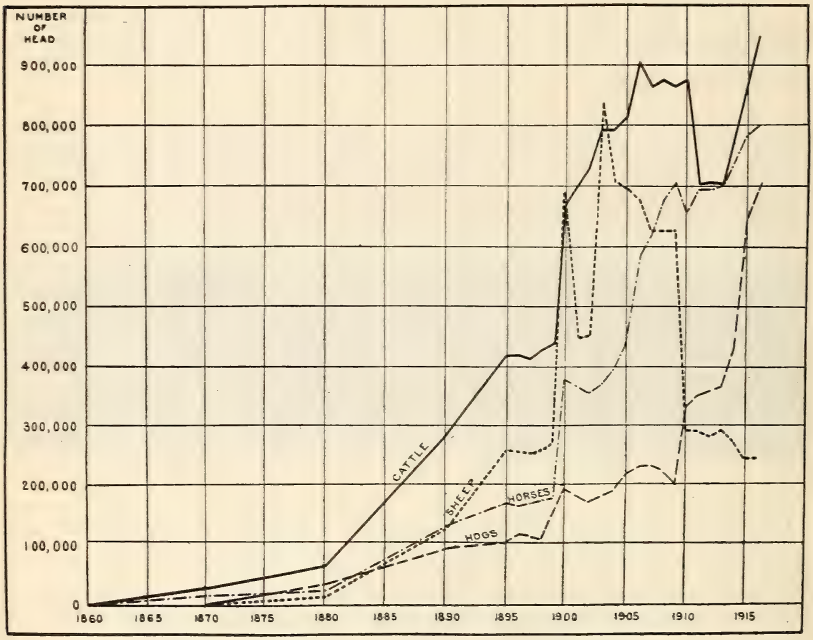

FIG. 5.—Live stock in North Dakota (1860–1915).

The years since 1899 have seen a marked increase in cattle and horses, this increase being brought about by production on farms as distinguished from that on the more extensive ranches. Sheep, being well adapted to the broader range, have decreased as the land has been developed into farms. However, sheep production on the farms of the State probably increased somewhat during 1916 and 1917.

Hogs have increased in number since 1909, amounting to more than 700,000 head in 1916.

The lines in figure 5 show that there was a decrease in horses and hogs, and particularly in sheep, following 1900, and in cattle following 1910. These decreases undoubtedly were due to scarcity of feed, which caused the sale or loss of large quantities of breeding stock. Both 1900 and 1910 were years of exceeding drought, particularly during the growing months of April, May, and June.

LABOR.

To determine the number of men required to operate a farm, representative operators were asked as to the amount of labor hired, amount of work done by members of the family other than the operator, and amount of work done by the operator himself. The average farm of 640 acres, with 480 acres in crops, requires approximately 8.5 months of time of the operator. Some farms utilize labor by other members of the family, and this was calculated on the basis of the number of months employed; other farms hire labor by the month; the total of these two items of labor average 17.3 months per farm. Extra labor was hired by the day during haying, harvesting, and thrashing, averaging 84 days per farm, or the equivalent of 2.9 months. In general, farms using family labor do not hire outside labor by the month. The 640-acre farm with 480 acres of crops requires the equivalent of approximately four men (including the operator) during the season of seven months. Each man employed under average farm organization, therefore, does the work equivalent to that required on 120 acres of crops. More men are required during harvest than during plowing and seeding, and scarcely any extra labor is needed for a period between planting and harvest.

The amount of overhead labor—that is, labor necessary to the upkeep of the farm but not applied directly to productive enterprises—is 16.2 per cent of the total labor utilized on the farm, as estimated by 40 farm operators. This overhead labor is included in the above calculations.

Labor is unevenly distributed on the grain farms of the State, inasmuch as work on the grain crops is required at about the same time for the same operations on all crops. In the case of the four leading grains—wheat, oats, barley, and flax—the work of plowing, preparation, and seeding is practically completed by May 31, and harvesting and thrashing are done between August 1 and September 30. On many farms a considerable amount of plowing is done in the fall, in which case nearly twice as much man labor is required during the critical period of late summer and fall as during preparation and planting.

While the season in North Dakota is comparatively short, not much time is lost because of unfavorable weather. On the average 144 days are available for field work, excluding Sundays, holidays, and days when it is too wet for field work. This available time is distributed as follows:

	Days.		Days.
April	14	August	22
May	22	September	20
June	21	October	22
July	21	November	2

FACTORS THAT CONTROL COST OF PRODUCTION.

Several important items enter into the cost of production of crops, each of which has a bearing on the profitableness of the various farm enterprises. In general, as each of these items increases in amount above a normal average the profits decrease. There are, however, one or two exceptions, such as the cost of twine and of thrashing, which are directly in proportion to the yield.

USE OF LAND.

The value of agricultural land, in general, is determined largely by its average productivity. Security of investment, profits from expected advances in value, and risk in production are other influencing factors. The earning value or productive value of land in North Dakota, however, is not always in proportion to its market value.

The payment to capital for the use of the land in older farming communities is usually equivalent to the current rate of cash rent for such land, less taxes and upkeep of buildings. In North Dakota scarcely any land is operated on a cash rent basis. In the rare cases, where obtainable, cash rent usually amounts to from 3.5 to 4 per cent on the investment. It was found in eastern North Dakota, where the average selling value of land is approximately $50 per acre, that, in general, when a farmer buys land, paying one-half the cost price in cash, the remaining $25 per acre is liquidated in about 15 years, interest being allowed at 6 per cent, indicating that he has made a net income of at least $2.50 per acre per year.

For purposes of calculation, if 6 per cent on the value of the land is assumed for use of land, no serious error will be made. In the Red River Valley this interest amounts to $2.97 per acre; in east-central North Dakota, $2.42; in west-central, $1.77; and in the western part, $1.34 per acre.

LABOR ON CROPS.

Man labor is one of the important factors of production. The amount required per farm was indicated on page 9. The amount required per acre for the leading crops under normal yields is shown in Table I.

TABLE I.—*Man and horse labor required per acre on various crops.*

[10-hour day.]

Crop.	Man days per acre.	Horse days per acre.	Crop.	Man days per acre.	Horse days per acre.
Wheat [a]	0.64	1.94	Flax [a]	.66	2.23
Oats [a]	.74	2.09	Corn	1.64	3.85
Barley [a]	.71	2.11	Potatoes	3.16	4.58

[a] Does not include thrashing.

The amount of man labor per acre varies somewhat with yield, since the time required for certain operations is greater if yields are heavy than if yields are light. The leading four grain crops require each approximately the same amount of man labor, since the same implements and crews are used for all of them.

Corn and potatoes require more work in cultivation and harvesting than do the small-grain crops. Most of the cultivation is done with two horses; the harvesting of corn is done by cutting with corn binder and shocking in the field. Potatoes are planted and dug by machine.

Horse labor is approximately the same on the leading four grain crops, but is considerably higher on corn and potatoes. For details of factors entering into the cost of horse labor, see page 15.

SEED PER ACRE.

The amount of seed used for planting by different farmers varies somewhat. The relation of the amount of seed for various crops to the yield of the same is shown on page 31. In seeding durum wheat, farmers generally use from one-quarter to one-half bushel more seed per acre than for other varieties.

TWINE.

Since practically all grain is harvested with the binder, large amounts of twine are required. The amount used per acre varies directly with the yield; when wheat yields 8 bushels per acre, 1.5 pounds of twine are required, and when wheat yields 20 bushels, 2 pounds. Barley and oats require slightly more twine per acre for harvesting than wheat. Where barley yields 12 bushels per acre 1.3 pounds are used, and where 30 bushels are made, 2.3 pounds. Oats require 1.5 pounds of twine when the yield is 34 bushels and 2.25 pounds when the yield is 45 bushels. Where flax yields 8 bushels of seed per acre, 1.3 pounds of twine are required. Not all flax is bound, however, it often being dropped in loose bunches by reapers or binders.

USE OF MACHINERY.

The use of machinery on North Dakota farms is costly in the aggregate, but when reduced to the acre basis the cost is comparatively small, owing to the fact that the large implements cover large acreages. The cost of operation of machinery may be classified under the three main headings: Depreciation, interest on investment, and repairs. A fourth group might be included which would cover storage, insurance, and taxes on machinery, but these amount to comparatively little.

The depreciation may be determined by estimating the life of the various implements; interest on investment in machinery is calculated on the value at the beginning of the year and not on the first cost, except during the first year; repairs cover necessary outlay for replacing broken or worn parts, paint, oil, etc. The average depreciation of farm implements in North Dakota varies considerably, depending upon the care and use of the various machines. The average life of implements is 12 years; in other words, the average annual cost for machinery depreciation is approximately 8 per cent of the new value.

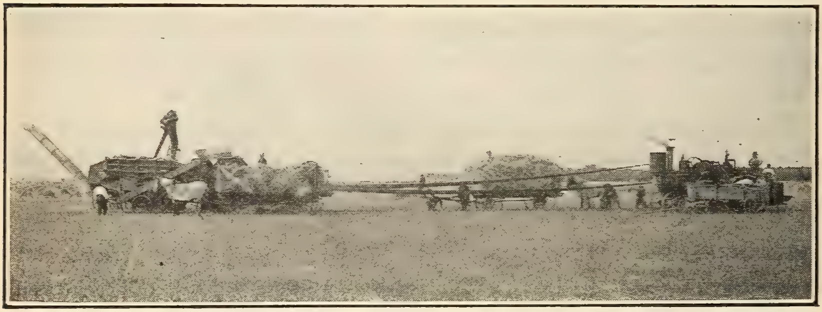

FIG. 6.—Thrashing in the field from the shock.

Repairs amount to approximately 6.5 per cent of the cost value of all farm implements on the average, although there is a wide variation in the amount of repairs required for different implements. For further details concerning the use of farm machinery, see page 17.

THRASHING.

Thrashing is a comparatively large factor in the production of grain, since large amounts of both man labor and horse labor are required in a very short time, the greater part of the thrashing in the State being done in less than 30 days, after about September 10. Most of the thrashing rigs are composed of a steam traction engine and separator with self-feeder and blower.

The usual thrashing crew (fig. 6) consists of about 20 men and 22 horses as follows: Eight to 10 men with teams hauling grain from the shock to the machine, four or five field pitchers, two "spike pitchers,"[1] one man and team hauling water and fuel, an engineer, and one or two separator men, one of whom is usually foreman of the crew. The farmer usually furnishes the necessary teams to haul the grain from the machine. In some cases the crews are boarded by the farmers for whom thrashing is done, while in others "chuck-wagons" or boarding cars are maintained by the crew.

The practice is becoming very common in parts of the State for farmers to stack grain as soon as it is sufficiently cured, so that the crew for thrashing is considerably reduced and thrashing is done at a smaller cost per bushel under these conditions (fig. 7).

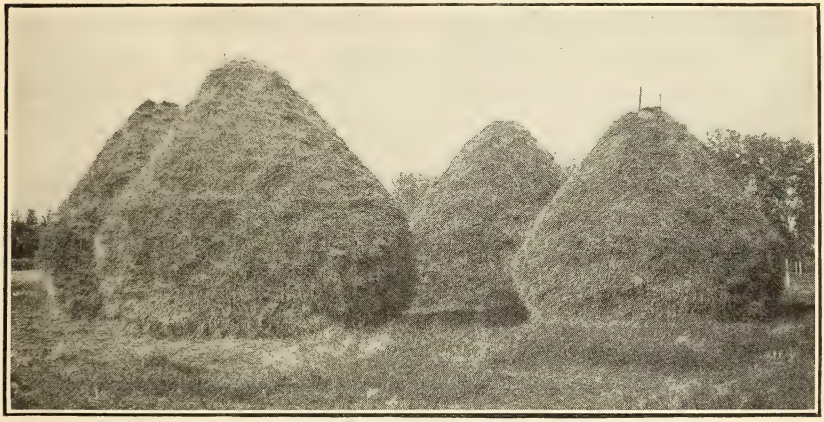

FIG. 7.—Many farmers now put up their grain in stacks.

Table II shows the charges per bushel in 1913 for thrashing from shock and from stack the four chief crops in eastern North Dakota, as reported by over 100 farmers.

TABLE II.—*Thrashing charge per bushel where done from shock and from stack (1913).*

[Cents per bushel.]

Thrashing method.	Wheat.	Oats.	Barley.	Flax.
From shock	10.4	6.4	6.6	25.7
From stack	6.1	3.8	4.0	11.4
Difference	4.3	2.6	2.6	14.3

Information was secured from 140 farmers regarding the amount of wheat of average yield that was stacked in an average day's work with different crews. Two men with one team stacked 10.7 acres, and three men with two teams stacked 14.3 acres. Assuming average costs of labor to be $2.50 per day for man and $1 per day for horse, which were approximately prevailing costs at that time (1913), the cost of stacking with the smaller crew was $7 per day or $0.65 per acre. With the larger crew the cost was $11.50 per day or $0.805 per acre.

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[1] Spike pitchers mount each loaded grain wagon as it comes to the machine and assist in pitching to the feeder of the separator.

With an average yield of 12 bushels of wheat per acre the saving by thrashing from the stack (from Table II) amounts to but $0.52 per acre. However, several factors taken together have an important bearing in this connection. If grain is stacked as soon as cured sufficiently, there is very little loss in quality of grain, except in rare instances. Scarcely any loss of grain from shelling occurs when thrashing is done from the stack, while considerable losses occur when the dry, ripe grain is taken from shock to machine. Also, the reduction in the size of the thrashing crew, made possible by having the grain stacked, is very important, especially during any shortage of labor. While a slightly larger total amount of labor is required when the grain is stacked, the distribution of the work over a much longer period is an advantage.

The average crew usually thrashes from 1,800 to 2,000 bushels of wheat, about 2,500 bushels of barley, and approximately 3,500 bushels of oats in a full day.

FARM UP-KEEP.

Of the total amount of man labor required on the farm, 40 operators estimated that on the average 16.2 per cent was required for overhead work not chargeable directly to any productive enterprise. This overhead labor is utilized in general repair of buildings, fences and ditches, repair of machinery, care of work stock, etc.

The amount of horse labor required in the overhead work is estimated to be about one-quarter as much as man labor.

MANAGEMENT OF FARMS.

The management of North Dakota farms is somewhat more costly than that of farms in some other sections. In determining this cost the value of the operator's time was assumed to be the value of his actual manual labor at current wages plus the estimated value of his management. The average farm operator puts in the equivalent of about eight months of actual work, averaging 21 days per month. This allows him credit for caring for productive stock in winter at the rate of about 30 hours per animal unit per year.

The average estimated value of management for 40 farms is $549. This amount is prorated to the productive enterprises in proportion to the number of days of work required on each. The total amount of man labor on crops and productive stock, together with outside labor, such as thrashing and hauling outside of the operator's own farm, is 505 days per year, so that the management charge is $1.09 per day of productive work on the average farm of 640 acres.

RISK.

As previously indicated, production is affected by several conditions over which the farmer has little or no control. Among these are rainfall, frost, hail, and market fluctuations. While failure for one year or for two successive years may be offset by high returns in seasons following for the farmer who has sufficient capital to carry him over the years of failure, many farmers lack sufficient capital or credit to carry them over even two years of failure. For some of these, one complete failure is equivalent to 100 per cent risk and for many more two crop failures mean ruin.

MAINTENANCE OF WORK STOCK.

The average cost of maintaining a work animal in North Dakota prior to 1916 was $105 per head, and in 1917, $145.

As stated previously, the average farm having 480 acres in crops requires 13 work stock, valued at $155 each. As the number of acres in crops decreases from that acreage, the number of necessary work stock decreases at the rate of about 1 horse per 38 acres, and as the size of the farm increases above 480 acres, the number of work stock increases at nearly the same rate. Large farms utilize horse labor slightly better than small ones, owing to their slightly better distribution of work.

The principal feeds for work horses in North Dakota are oats and hay, although corn and barley are occasionally fed. Straw is utilized to a large extent as a maintenance feed during the winter, oat straw being considered best. Records were obtained concerning feed for 462 horses, which show that, on the average, 142 bushels of oats and 3 tons of hay per year are fed to each horse. The amounts of each feed vary considerably, depending somewhat upon the size of the animals, but more particularly upon the combination of feed and the amount of work done by the animals.

The horses generally have free access to the straw pile, so that the amount of straw consumed can not be determined. However, this feed very often entirely replaces hay during the winter. Work stock are kept on pasture very little.

The hay utilized is generally the native prairie grass or slough grass, although tame hays are being produced to some extent. Among these are timothy, clover, and alfalfa.

The depreciation of work horses is an item of expense not usually considered by the average farmer. The number of years horses are useful for farm work varies considerably, depending upon use and care. Estimates from 100 farmers in eastern North Dakota relative to the number of years work horses are useful vary from 7 to 20 years, averaging 12 years. The average annual depreciation, therefore, is asumed to be 8.3 per cent of the prime value, which is usually considered to be the value at six years of age. As a matter of fact, very little depreciation occurs until after the animals are eight years of age. It has been shown[1] that a horse is worth 84 per cent of its prime value at 10 years of age, 70 per cent at 12 years, and 40 per cent at 16 years. The value of the average work animal changes very little between the ages of 5 and 9 years.

The shoeing of work animals is generally limited to those that are being used in hauling on hard roads or other hard surfaces. Some farmers shoe the front but not the hind feet. In ordinary field work, shoes are not necessary. Of 103 farmers, 69 had some of their horses shod, but only a small percentage had all of them shod. Of the total of 718 head on these farms the average prorated cost per horse was $0.89 per head per year.

Veterinary charges are a very small item and no data are available on this subject.

The assessed valuation of work stock in the State in 1914 was approximately $30 per head and the tax rate about 30 mills per dollar. Thus the average taxes per head amount to $0.90.

Information was secured from 48 farmers concerning the amount of barn room used for stabling. The buildings ranged in size from 16 by 22 feet for 9 animals to 38 by 80 feet for 32 animals. The average floor space utilized was 70 square feet per animal.

The time required to care for work stock varies considerably, depending upon the convenience of arrangements for feeding and for removing manure. Also, the number of animals per farm is a factor, the larger the number of animals the more total time required, but the less the time required per animal. The results of 129 records are given in Table III, the approximate time per horse being given.

TABLE III.—*Time required per day to care for work stock.*

Item.	Number of horses.									
	4		5		6		8		10	
	hrs.	*min.*	*hrs.*	*min.*	*hrs.*	*min.*	*hrs.*	*min.*	*hrs.*	*min.*
Total time per day	1	53	2	1	2	20	2	43	2	45
Minutes per horse		28		25		23		20		16

The average work horse in North Dakota is utilized for 79 days of productive labor on the farm. While 144 days are available for field work during the crop season, practically all of the work done is in planting and harvesting time, as there is very little field work to be done for a period of from six weeks to two months in June and July. Some productive work is done during the winter in hauling grain to market. A small amount of work in general farm upkeep is done by horse labor.

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[1] United States Department of Agriculture Bulletin 413, page 11.

USE OF IMPLEMENTS AND MACHINERY.

The prewar value of machinery on the average North Dakota farm visited (averaging 480 acres in cultivation), was $1,757 (cost price). This figure does not include automobiles, tractor-plow rigs, or thrashing rigs. Each acre of crop land, therefore, must bear the maintenance charges for $28 worth of machinery.

Table IV shows some of the facts relative to the utilization of the more important implements, as indicated by information secured on 40 farms in North Dakota. These figures represent prewar conditions, a marked advance having been noted in 1917. The average life of implements varies somewhat, with consequent variation in the amount of depreciation. The average life of all farm implements is 12 years, making the annual depreciation 8.3 per cent.

The annual repairs for the various implements depend upon the amount of use and care. The high repair cost of gang plows is due to the replacement and sharpening of shares. The big item of repairs of binders consists of new canvases, which are generally replaced every two to four years. The average annual cash expense for repairs amounts to 6.7 per cent of the first cost of implements.

TABLE IV.—*Average value, life, annual repair cost of various implements, and the area covered by each (prewar data).*

Implement.	Average value (new).	Average life.	Annual repair cost.	Acres covered per year (each).
		Years.		
Gang plow	$75	13	$16	174
Disk harrow	44	12	3	165
Drag harrow	23	9	1	670
Roller and packer	53	19	1	240
Grain drill	130	11	4	300
Grain binder	144	10	13	168
Mowing machine	49	12	4	54
Hay rake	30	13	1	67
Manure spreader	129	12	7	31
Corn binder	132	10	7	49
Corn planter	43	16	2	61
Sulky cultivator	36	12	1	57
Wagon gears	59	18	2	
Grain tanks	28	11		
Wagon racks	14	6		
Bobsleighs	53	15		
Gas engine	74	13	2	
Harness (set)	33	11	1	

The last column of the table shows the average number of acres each implement covers each year, in the usual farm practice. Nearly all of the larger machines cover from 150 to 300 acres each per year. This is one of the factors which determine the comparatively large size of farms in North Dakota. None but large farms can utilize these labor-saving implements efficiently.

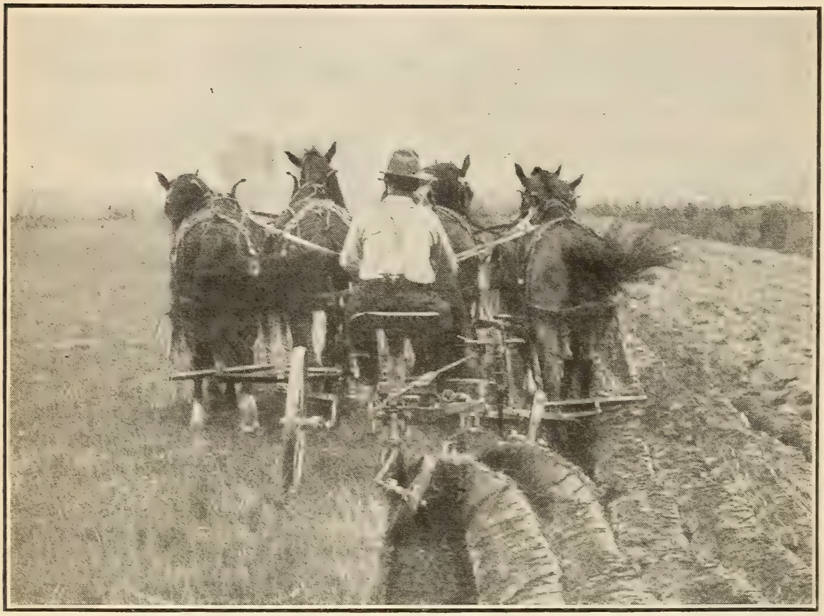

FIG. 8.—The gang plow drawn by the five good horses turns from 5 to 6 acres in a day.

The gang plow (fig. 8) cuts two furrows of 12 to 14 inches each; the most common gang is the 28-inch. The majority of farmers use five horses on the gang plow, although a large number use only four.

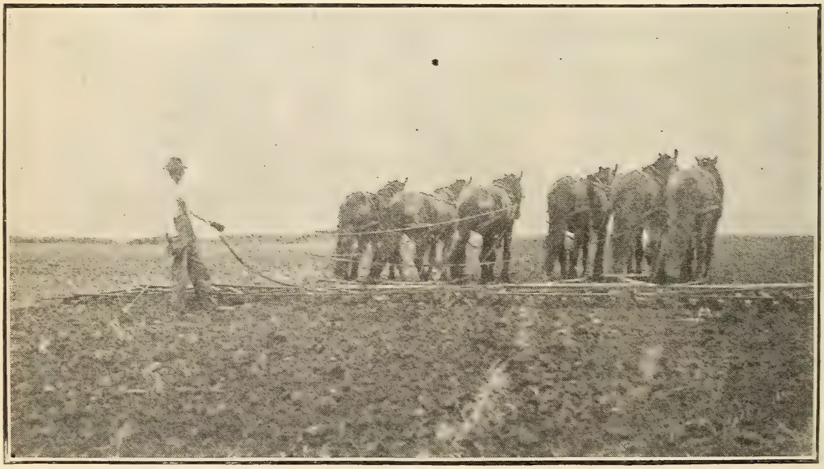

FIG. 9.—The spike-tooth harrow covers from 40 to 60 acres per day, depending upon the width of the harrow and size of the team.

A very few use six horses on this implement. Usually three horses are placed abreast and two in the lead, but when four horses are used they are generally driven abreast.

The harrow (fig. 9) varies in width from 16 to 32 feet, and occasionally greater widths are used. This implement is usually constructed in 4-foot sections and may be made any width that is a multiple of 4 by the addition of more sections. Four horses are used most commonly on widths from 16 to 24 feet, but five and six horses are used on the wide harrows.

The disk harrow (fig. 10) is used generally for pulverizing cloddy soil. Sometimes it is used in place of a plow in preparing stubble land for the succeeding crop, but this practice is not common. This implement generally consists of from 16 to 24 disks on two shafts set end to end, which may be set at various angles to each other by means of levers. The most common size of disk is the 16-inch, though the disks vary from 12 to 18 inches in diameter. Four horses are most commonly used on the disk harrow, with one man as driver, who usually occupies a seat on the implement.

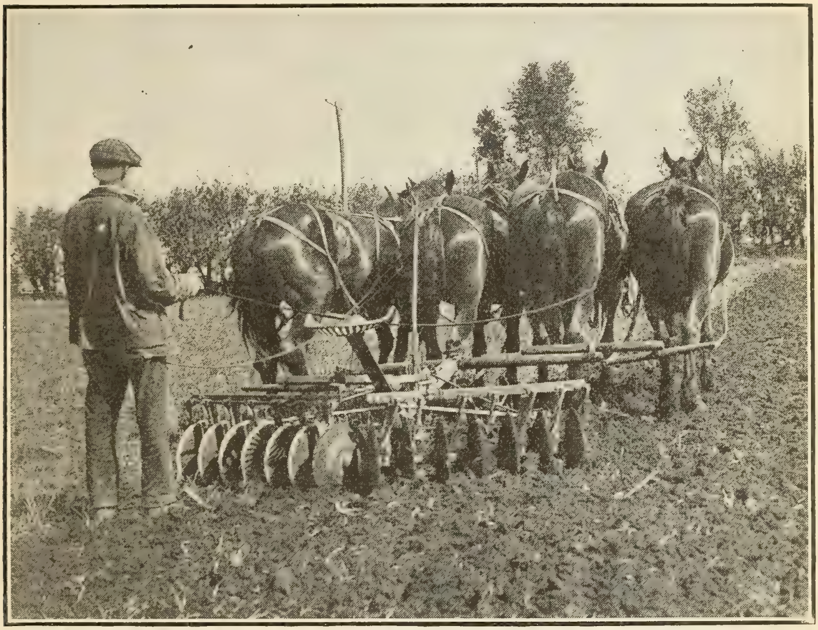

FIG. 10.—The disk harrow is an implement especially useful on packed or cloddy soil.

Grain drills (fig. 11) are ordinarily from 8 to 12 feet wide, occasionally a 16-foot implement being used. Both the shoe and the disk type are in rather common use. Almost invariably four horses are used on the drill in North Dakota.

Rollers and packers are used to some extent, but are not necessary implements. They are used for pulverizing the surface and packing the soil into a firm seedbed. Figure 12 illustrates a type of subsurface packer. Four horses are normally used on either roller or packer.

The binder (fig. 13) is one of the most complicated and most expensive implements used on grain farms. Those used in North Dakota are usually of from 6- to 8-foot cut. In nearly all cases four horses are used on this implement, but occasionally three are used.

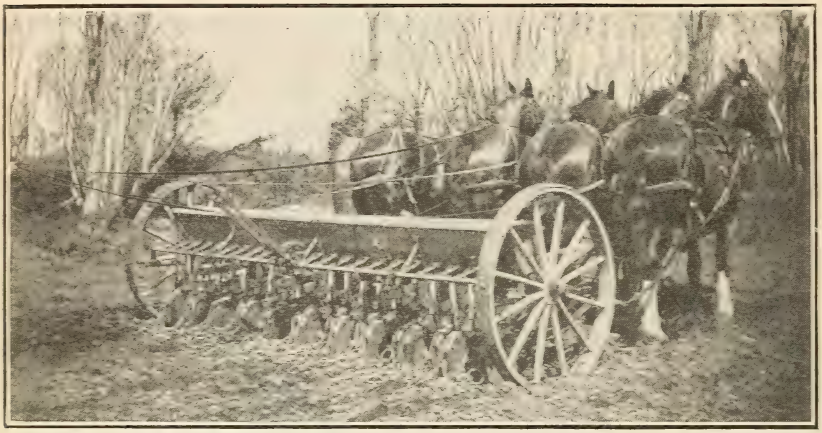

FIG. 11.—The grain drill is one of the essential large implements on the grain farm.

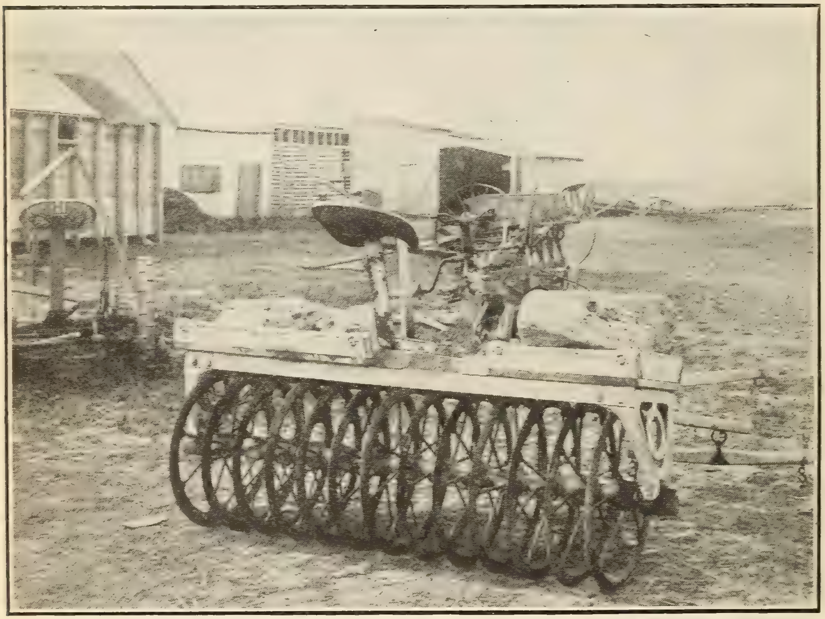

FIG. 12.—A subsurface packer that makes a firm seedbed and breaks the clods, leaving a dust mulch.

It is not uncommon for a farmer to allow the binder to stand in the open during the year, the canvases being removed and placed under cover. While this practice increases the rate of depreciation to some extent, the binder does not suffer as much from exposure to the weather as do certain other implements, notably those largely made of wood.

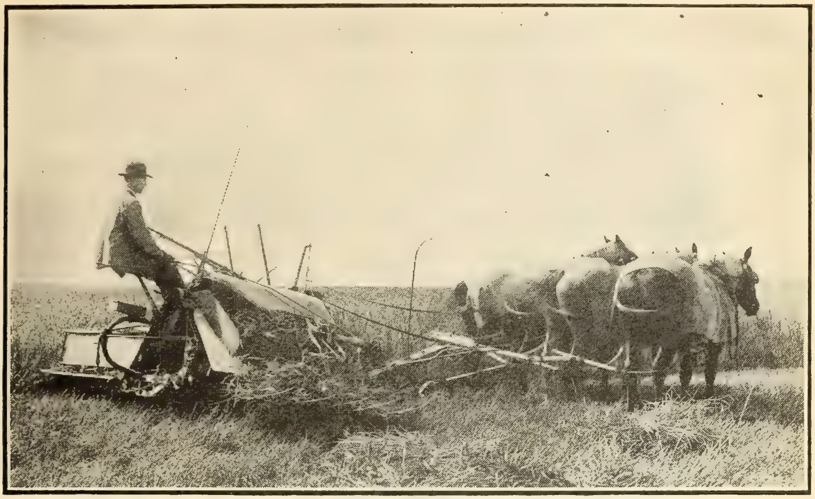

FIG. 13.—The self-binder is most commonly used for harvesting grain.

Mowing machines and hay rakes (generally two-horse size) are found on practically every farm (fig. 14). Each of these implements is nearly all of iron, and depreciation is therefore not great when they are left in the open.

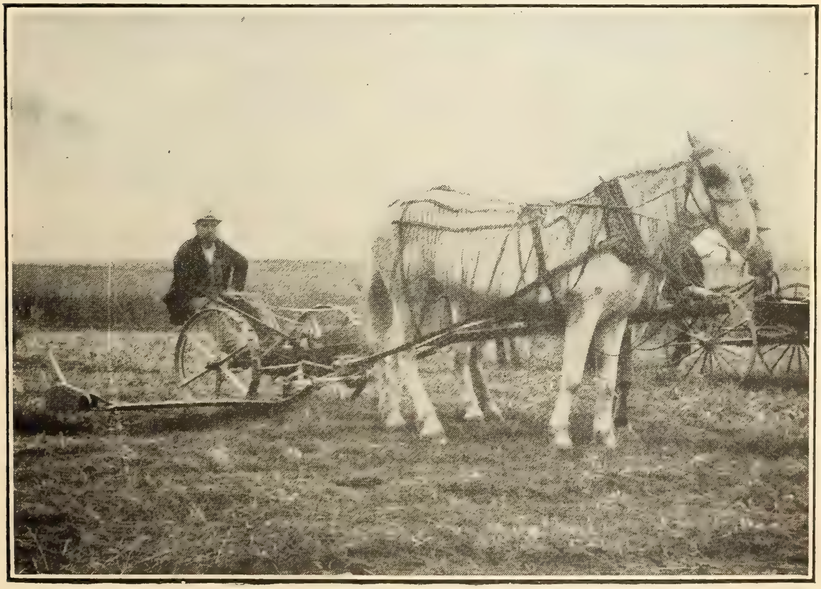

FIG. 14.—The mower. Often several acres must be cut to get a ton of prairie hay.

The manure spreader has lately come to be a very common farm implement in certain parts of North Dakota, as the farm operators have begun to appreciate the value of manure. The increase in amount of live stock has caused an increase in the amount of manure, and this is now being utilized more efficiently. Manure spreaders vary in make and size; those of from 60 to 70 bushels capacity are common. Two, three, or four horses are used, depending on capacity. Where the barn is built with a driveway through it the spreaders are loaded directly from the gutters. In other cases overhead carriers are used, which dump into the manure spreader outside the barn.

The larger machines for corn production are now common, the two-row check planter being used as well as the corn binder. Two horses are used on the planter and four on the binder. The 2-horse riding cultivator for corn and potatoes is more common than the walking cultivator. Very little wood is used in its construction; it lasts for a dozen years with scarcely any repairs.

A farm wagon is required for approximately every 100 acres of crop land on the farm. The wide-tire wagon is most common. Grain tanks of from 60 to 125 bushels capacity are found on every farm, one to about every 270 acres. Racks for hauling hay and grain are short-lived, being almost entirely of wood construction.

Stationary gas engines are found on nearly every farm, many farms having two or even three of them. These are used for grinding feed, pumping water, elevating grain, etc. They vary in size from one to four horsepower, the one and one-half horsepower engine being very common. The prewar cost of these was approximately $30 per horsepower, with considerable variation according to make of engine. The small gas engine has now been simplified to such an extent that anyone of average intelligence can operate it, and it is now practically a necessity on the North Dakota farm.

On those farms where potatoes are raised, both planters and diggers are used. Diggers are four-horse implements, and both diggers and planters are very necessary where large acreages of the crop are raised.

Buck rakes and hay stackers (fig. 15) are not infrequently found on the larger farms where much live stock is kept and a considerable acreage of hay is harvested. It is only on such farms that these implements are profitable, inasmuch as the depreciation and repair charges on them are comparatively high.

A large amount of small tools and implements is necessary to the operation of the farm, although many farms have considerably more of these articles than are essential.

Thrashing outfits (fig. 6) are often owned and operated by farmers, although they generally do considerable outside work, except on the very large farms. Not infrequently two or more farmers in a community own a thrashing rig jointly and do their own thrashing as well as some outside work. In some cases rigs are owned and operated by men who are not farmers but who make thrashing a business. Steam engines cost from $1,500 to $3,000 (1914) and separators cost from $750 to $1,200. The cost usually depends on the size more than any other factor. An engine lasts from 12 to 20 years, according to the use and care given it. The life of a separator is not so long, being from 7 to 15 years.

It was formerly the practice to use straw for fuel, flax straw being the best for this purpose. During the last five years this practice has been almost entirely discontinued, and now coal is the fuel commonly used. An ordinary 25 to 30 horsepower engine consumes from 1,800 to 2,000 pounds of soft coal per day. It was suggested that during the shortage of coal (1918) the former practice of burning straw be revived.

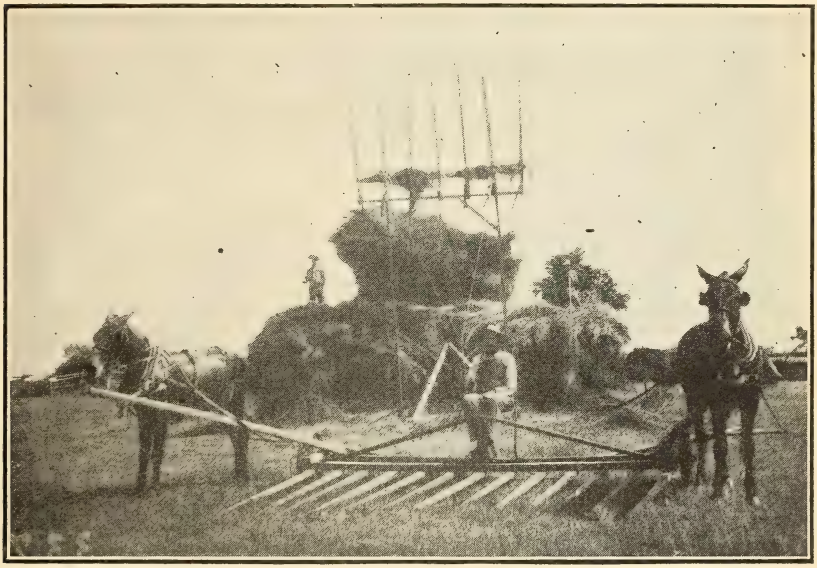

FIG. 15.—Buck-rake and hay-stacker commonly used where a considerable acreage of prairie hay is cut.

The use of straw as fuel involves the use of a larger amount of labor than where coal is used, as a fireman is required to feed the straw to the fire box almost continuously, and it is necessary to keep one man and team hauling the straw from stack to engine. Furthermore, the risk from fire is great, on account of the proximity of a load of straw to the engine and the danger from flying sparks.

Improvements and simplifications of the gas tractor have made it possible for many more farmers to use it now than formerly. No data are available as to the number of tractors on farms in North Dakota at present (1918), but among 37 representative farmers in the eastern half of the State, six owned and operated tractors for plowing and small amounts of other farm work.

The automobile now occupies an important place on North Dakota farms. Of 34 farmers, unselected, and located in the eastern half of the State, 27 operated cars of some kind, and one farmer kept two. The value of the car to the farm was determined largely by the distance from the market point.

WHAT CREWS CAN DO.

The amount of work that can be done in a normal day is important, especially in certain operations that must be done within a limited time. A very large part of the field work on North Dakota farms is done with one man and four horses. The number of acres per day covered by this crew in various operations is shown below:

	Acres per day.
Plowing	5
Harrowing	47
Disking	17
Drilling	20
Harvest wheat	16
Harvest oats	15
Harvest barley	16
Harvest flax	15

One man and five horses with a gang plow turn 5.2 acres per day and one man with six horses turns 5.5 acres per day.

A few farmers visited used three horses in harvesting wheat, and covered an average of 10.6 acres per day.

In shocking wheat one man can not quite keep up with a 4-horse binder, being able to set up 15.6 acres per day on the average. One man shocks 15.6 acres of oats or 17.8 acres of barley per day on the average.

In hauling grain to market one man and two horses haul an average of 132 bushels per day where the average length of haul is 6 miles. Two loads are hauled of approximately 65 bushels each. Where the distance is within 4 miles the average day's haul is 172 bushels (three loads) and within 2 miles, 312 bushels (five loads).

In haying, one man and two horses cut an average of 9 acres per day and rake 18 acres.

In stacking grain various crews are used, but the two most common are two men with one team and three men with two teams. The former crew stacks on the average 10.7 acres per day and the large crew stacks 14.3 acres of wheat of average yield of 12 bushels per acre.

There is a wide variation in the size of crew and proportion of men to teams in stacking hay, determined rather by the available labor than by efficiency of crews. The average amount of tame hay stacked, as reported by 15 farmers, was approximately 5 tons per day per man, and the average proportion of men to horses was approximately two men to three horses. The average yield of hay was 1.15 tons per acre and it was stacked in the field where the length of haul was short.

A very large part of the grain used for seed must be cleaned by running through a fanning mill before planting. Ordinarily this is a two-man job and in many cases the mill is run by motor. The following data relative to cleaning grain show the number of bushels per day that are cleaned:

	Bushels per day.
Wheat	108
Oats	119
Barley	92
Flax	29

DATES OF OPERATIONS.

Estimates from several hundred farmers, as well as actual records from several covering periods of from 12 to 30 years, indicate that, on the average, field work begins about April 18 and ends about November 6. These dates are subject to about 20 days' variation either way, depending upon the season. It happens not infrequently that some field work is done in March.

Any one of several operations may be the first done in spring. If plowing was done in the fall, either harrowing or disking may be done first, and seeding may follow within a day or two. Table V shows the most common dates between which the principal operations are performed. These dates are subject to some variation, depending upon the season, varieties of grains planted, etc. For example, oats are usually planted between April 26 and May 20, and are harvested generally a day or two ahead of wheat; if, however, a late variety of oats is planted the harvest may be 10 or 20 days later than the average.

TABLE V.—*Dates of operations on wheat, oats, barley, flax, corn, and potatoes.*

Crop.	Plowing (fall).	Plowing (spring).	Harrowing.	Disking.	Planting.	Harvesting.
Wheat	Sept. 26–Oct. 17	Apr. 18–May 24	Apr. 18–May 28.	Apr. 18–May 19	Apr. 19–May 12	Aug. 10–Aug. 20.
Oats	do	do	do.	do	Apr. 26–May 20	Aug. 8–Aug. 15.
Barley	do	do	do.	do	May 12–May 28	Aug. 6–Aug. 13.
Flax	do	do	do.	do	May 31–June 15	Sept. 1–Sept. 15.
Corn	do	do	do.	do	May 20–June 10	Sept. 5–Sept. 25.
Potatoes	do	do	do.	do	May 20–June 3	Sept. 20–Oct. 12.

It is scarcely possible to separate the dates of plowing and preparation of the land for the various crops, since these operations all overlap; furthermore, land that was plowed and prepared for a certain crop is often seeded to another on account of seasonal conditions, or for some other reason.

Thrashing is usually done in from one to three days on the average farm, and is generally from 25 to 35 days after the beginning of harvest. If flax is raised it sometimes happens that a separate job of thrashing is necessary because this crop is harvested much later than the others.

Farmers differ somewhat in opinion as to the latest safe seeding date in the spring for the various crops. The following dates are the averages of the estimates of over 200 farmers:

Wheat	May 12	Barley	June 3
Oats	May 21	Potatoes	June 6
Corn	May 28	Flax	June 11

Two important considerations should be taken into account in connection with these dates, namely, varieties and weather conditions. Varieties that mature quickly may be planted later than those requiring longer growing periods. When the spring season is very unfavorable, it is sometimes necessary to plant later than the above-indicated dates and take the risk of not maturing a crop.

Cultivation of corn and potatoes is usually done in June and July, the inclusive dates for corn being June 5 to July 15, and for potatoes from June 12 to July 30.

The number of days for the production of the various crops varies considerably. The following data show approximately the number of days from planting to harvest of the leading crops:

	Days to maturity.		Days to maturity.
Wheat	112	Potatoes	129
Oats	106	Flax	94
Barley	87	Millet	78
Corn	108		

The amount of time required from planting to harvest varies, depending upon the variety of grain; the above figures represent the average for the various crops produced on several farms covering periods of from 12 to 30 years. The season also has a marked effect on the length of time required. For example, the average season from seeding to harvest of wheat in 1910 was but 97 days, while the average for all years covered in the records is 112. The 1910 growing season was one of the driest on record for this area. Further, grain crops planted late in the season generally mature in a shorter time than the earlier planted crops; a difference of from 10 to 12 days is noted in the case of wheat and oats.

YIELDS.

Success in farming in North Dakota depends very largely upon yields, and the factors that affect yield are of interest to every farmer. Some of these factors are not under human control, but many of them are, and even the uncertain factors may be in some degree controlled by the prospective farmer by avoiding localities unfavorably situated.

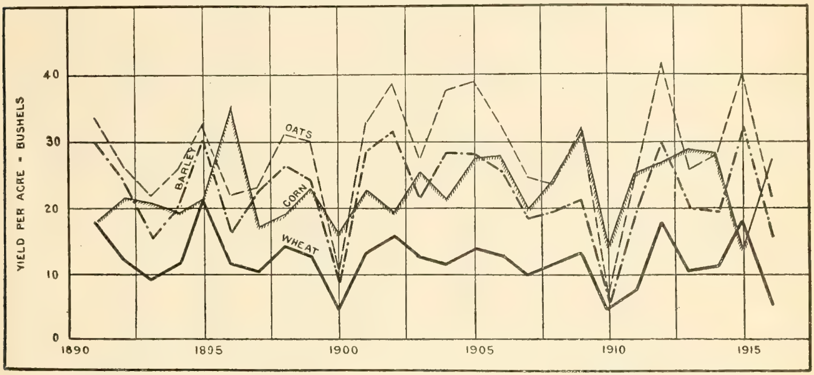

FIG. 16.—Yield per acre of wheat, oats, barley, and corn (North Dakota, 1891–1916).

Yields per acre of all crops vary from year to year for various causes. The lines in figure 16 show the average yields that have been made in the State from 1891 to 1916, inclusive. Wheat, of course, is of greatest importance. It generally happens that where low yields of this crop are made the production of other crops is also low. It is noted that there is a marked parallelism in the lines for wheat, oats, and barley; the corn line, however, does not follow the general order very closely.

Within the limits of the growing season, the yield of these crops of wheat, oats, and barley are dependent upon rainfall to a greater extent than upon any other factor. Corn is dependent upon rainfall also, but is affected very greatly by temperature. Its growing season is also different from that of the other grain crops.

The lines in figure 17 show the relation of rainfall to yield. The line at the bottom of the figure represents the combined rainfall in inches during the months of May and June for each year from 1891 to 1916, and the upper line is a crop index representing the yields of wheat, oats, and barley. It is noted that there is a marked parallelism in these lines, that is, where the rainfall is greatest the yields are uniformly largest. There are two exceptions to this order, one for 1896 and another for 1914. In both of these years there was a large amount of rainfall during May and June, in each case more than 8 inches falling in such short periods that much grain was drowned out. Three other years show rainfall during these months in excess of 8 inches, but so distributed as to cause increases rather than decreases in yields.

It should be noted that in 1900 and 1910 exceptionally low yields were made, owing to drought conditions. In 1900 the annual rainfall was about normal in the State (18.6 inches), the shortage of May and June being made up during the other months, but 1910 was very dry during the whole year, the total rainfall being but 12.4 inches.

Other data not here presented show that there is only a slight relationship between rainfall in April and yield. Neither is there any marked relation between annual rainfall and yield of these crops. May and June are the critical months. With a rainfall of 6 inches distributed over the months of May and June, at least normal crops may be expected.

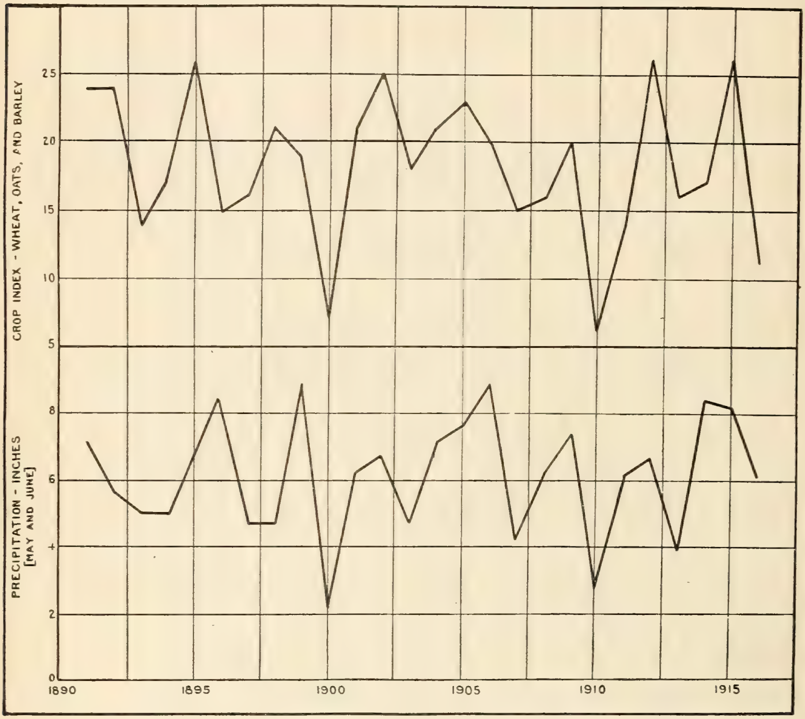

FIG. 17.—Relation of rainfall in May and June to yield per acre.

TABLE VI.—*Yield per acre for various crops in North Dakota (Bureau of Crop Estimates' figures for 1891–1916, and records of actual yields obtained in this investigation for 1912–13–14).*

Source of figures.	Yield per acre (bushels).					
	Wheat.	Oats.	Barley.	Flax.	Corn.	Potatoes.
Bureau of Crop Estimates	12.3	28.1	22.4	[a] 8.6	22.8	95
This investigation	13.2	33.9	21.7	7.9	33.8	87

[a] Average 1902–1916 inclusive.

Table VI shows the average yield per acre of the leading crops of the State. There is a wide variation in yield from year to year and also between farms. The lowest yield of wheat recorded for the State is 4.9 bushels in 1900 and the next lowest 5 bushels in 1910. Other crops made their lowest yields also in these years.

RELATION OF LAND VALUE TO YIELD.

Little relation appears between the selling price of land and the yield per acre of wheat. Table VII shows the relation of land value to yield per acre for the three leading crops.

TABLE VII.—*Relation of land value to yield per acre of wheat, oats, and barley.*

[Figures are per acre.]

Wheat.		Oats.		Barley.	
Value of land.	Yield.	Value of land.	Yield.	Value of land.	Yield.
	Bushels.		*Bushels.*		*Bushels.*
$19	12	$23	28	$27	22
31	13	34	32	41	21
50	14	52	38	58	22

As previously pointed out, other factors than yield appear to determine the price of land in North Dakota. Land in the western part of the State, valued at $19 per acre, produced average yields of 12 bushels of wheat; while land in the Red River Valley, valued at $50 per acre, produced average yields of only 14 bushels. However, the risk in the western portion is many times greater than in the eastern, because of the fact that seasons of drought occur more frequently in a given period. This risk is reflected in the value of the land. Furthermore, the fact that the annual rainfall is approximately 6 inches greater in the eastern portion than in the western makes it possible to have a much wider diversification of crops and stock in the east than in the west.

RELATION OF TILLAGE TO YIELDS.

The operations in which an increase of labor may affect yield are plowing and the various operations of preparation, such as harrowing, disking, rolling, etc. The amount of labor used in seeding is practically the same on all farms, the ground being covered with a drill. The efficient plowing of the land is of prime importance. More depends upon proper plowing than upon any other operation. A few farmers were found who planted wheat without plowing, disking the seed into the stubble. These farmers made yields of 10 bushels or under per acre.

The amount of working of the soil required for best production is dependent largely upon the character of the soil and weather conditions. Under normal conditions tillage equivalent to one disking and twice over with the harrow gives better results than where greater or less amounts of labor are utilized. Frequently time is lacking for more than one harrowing, and when this is the case, yields are generally about 2 bushels of wheat per acre less than when the land is disked and harrowed twice.

The practice of going over the land with the harrow as soon as possible after each rain, conserves moisture and tends to increase yields. Where land is in a fair state of tilth after plowing, disking is omitted and care is exercised to conserve moisture by harrowing.

Leaving the land as rough as possible during the winter is advisable, as thus it catches and retains more snow than when the surface is smooth.

SUMMER-FALLOWING.

Summer-fallowing is practiced by comparatively few farmers, since experience has shown very little difference in net returns between this method and that of planting a crop each year. In some cases this method is advisable, particularly where the land is weedy, as clean cultivation for a season will eradicate many of them. In general, however, summer-fallowing does not appear as profitable for North Dakota as crop production each year.

FALL VERSUS SPRING PLOWING.

In so far as yield is concerned, it appears that, in general, it makes very little difference whether the land is plowed in fall or spring. Weather conditions may cause one method to be highly desirable in one year while in another the same practice may prove a poor one. Among nearly 100 farmers, 60 plowed for wheat in the fall and the remainder plowed in the spring. Records from a number of farms indicate on the fall-plowed land a yield of 13.1 bushels and on the spring-plowed 13.6 bushels per acre. With oats and barley slightly larger yields are made by fall than by spring plowing, a difference of from 4 to 6 bushels being noted. However, only 18 farmers out of 90 plowed in the fall for these crops.

Aside from the question of yield, there is a very great advantage in plowing in the fall where possible. The period for plowing, preparation, and sowing in the spring is short, and plowing is the operation that requires most time. Even though the weather may be disagreeable in the fall, as much plowing should be done after harvest and thrashing as possible, since it makes a much more even distribution of labor and makes it possible to seed at the earliest possible date in the spring.

SEED.

Within certain limits little difference in yield of grain is caused by sowing different amounts of seed. Much depends upon the season in this regard, small amounts of seed giving better results in dry seasons, because there may not be sufficient moisture to mature a heavy stand, while a light stand may come to full maturity. The more space allowed each plant the greater the amount of stooling, so that where grain is sown thin, more stalks of grain mature from the same individual seed than where a thick planting is made.

The amount of seed commonly sown per acre, and which produces the best yields in the average, falls between the following limits:

		Minimum.	Maximum.
Wheat	bushels	1.0	2.0
Oats	do	1.5	2.5
Barley	do	1.3	2.0
Flax	do	.4	.7

STUBBLING-IN GRAIN.

The practice of disking grain in the stubble of the previous crop without plowing is followed to some extent, and information was obtained from 136 farmers in 35 counties of North Dakota as to the profitableness of the practice. The following is a summary of the information obtained:

112 farmers reported the practice as without profit.
33 farmers reported one-fourth to one-half normal yield.
28 farmers reported a marked increase in weeds.
13 farmers reported normal yield when previous crop was properly tilled.
7 farmers reported normal yield under any previous condition.
10 farmers reported the plan satisfactory only for rye.

A few scattered farmers reported that it is more profitable to summer-follow than to stubble-in grain. Others reported that it is more profitable to let the land lie idle than to stubble-in, since stubbling-in often fails to return the equivalent of the seed sown.

Three principal arguments are used in favor of the practice: (1) A saving is made in time and cost of preparation and in consequence a larger area can be seeded; (2) stubble of the previous crop left over the winter catches and holds snow; and (3) the quality of the grain is said to be better from stubbling-in than from planting on plowed ground.

There are several serious disadvantages: (1) Low yields, from one-fourth to one-half of normal; (2) fields dry out rapidly, as less moisture is absorbed than by plowed ground; (3) the ground is harder to plow the following year; (4) a much shorter straw is made; and (5) weeds and insects are increased materially by the practice.

Ground previously planted to potatoes, corn, or flax appears to give best returns if grain is sown without previous plowing for the crop.

In general, it would seem that the practice of stubbling-in is not to be advocated except possibly in the case of winter rye. Many farmers in the eastern part of the State believe that stubbling-in rye is entirely justified.

ROTATION.

Hitherto very little consideration has been given to the subject of crop rotations by the farmers of North Dakota. Of 40 farmers interviewed on this subject, only 12 gave any information as to order of planting crops, the greater number stating that they gave little or no attention to the matter. A few said that they changed from one crop to another as often as possible. Only seven farmers, and these in widely separated counties, were found who followed a fairly uniform system of rotation. These men adhered as closely as possible to this order: Barley, 1 year; wheat, 1 year; oats, 1 year; summer fallow or intertilled crops, 1 year.

The greatest difficulty in establishing a system of rotation is the fact that the type of farm is based on a one-crop system, wheat production occupying such a large part of the farm area. However, the increase of stock production is materially remedying the situation, and tame hay and other feed crops are occupying larger and larger percentages of farm areas. Alfalfa, timothy, and clover, and corn are now of some importance, though 10 years ago these crops were scarcely known in the State.

Thus far no serious decrease in yields, due to depletion of the soil, has been noted in North Dakota. New land, that is, land that has never produced anything but prarie grass, is being brought into cultivation every year in all parts of the State, with the possible exception of some of the Red River Valley counties. As long as this condition prevails and wheat occupies so large a proportion of the crop land, rotations will hardly be given serious consideration by the farmers.

MANURE.

A decade ago scarcely any manure was applied to the land, because there was little to apply. Practically the only stock on the farms were work animals. At present, however, from 5 to 50 animal units[1] of productive stock or even more, besides the work animals, are found on every farm, so that the amount of manure now produced annually is worthy of consideration. In general, on the average farm of 640 acres, manure is applied to 30 acres or more every year. This factor is and will continue to be of great importance in maintaining yields within the State.

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[1] An animal unit is a mature horse or cow or as many smaller animals as require the feed of a horse or cow, approximately 2 young cattle, 5 hogs, 7 sheep, or 100 hens.

There has been a marked improvement in the utilization of straw within the last 10 years. Formerly, it was a common sight at night in the late summer or fall to see from 50 to 100 straw piles burning within the circle of the horizon. At present the amount of straw burned is greatly reduced, since its value as feed, and as fertilizer when rotted, is becoming better understood.

SUMMARY OF COST FACTORS.

In order that a basis may be available for determining the values of various items that enter into the cost of production of grain in North Dakota, the various cost factors for the four leading crops are summarized in Table VIII. Practice varies from farm to farm, but the figures given are based on 350 farm records, and may be taken as representative.

TABLE VIII.—*Summary of items entering into the cost of raising wheat, oats, barley, and flax in North Dakota.*

	Wheat	Oats.	Barley.	Flax.
Seed, bushels per acre	1.2	2.0	1.7	0.5
Man labor, days per acre	.64	.74	.71	.66
Horse labor, days per acre	1.94	2.09	2.11	2.33
Use of machinery, per acre	18 per cent of first cost divided by number of crop acres in farm.	Same as for wheat.	Same as for wheat.	Same as for wheat.
Twine, pounds per acre	1.78	1.88	1.75	1.33
Thrashing, cents per bushel	10 (15)	6 (9)	6 (10)	20 (35)
Management	$1.09 per man day on crop.	Same as for wheat.	Same as for wheat.	Same as for wheat.
Use of land, per acre	6 per cent of land value.	do	do	Do.
Manure, tons per acre	0.65	do	do	Do.

"Man labor, days per acre" and "Horse labor, days per acre" include all the work done upon the respective crops except thrashing, which is accounted for in the direct thrashing charge per bushel. Among the items included in the labor are plowing, disking, harrowing, planting, cutting and shocking, hauling grain from thrashing machine, and hauling grain from farm to elevator. In cases in which time was occupied in cleaning and treating grain or by any other operations in connection with the crops, this labor has been included.

Under "Use of machinery" it is found that the sum of interest on investment, depreciation cost, and repair cost amounts to 18 per cent of the new value of the equipment utilized on the farm, excluding from all calculations tractors, thrashing rigs and automobiles. Since all crops require so nearly the same use of machinery, as indicated by the amount of horse labor expended on each, the machinery cost per acre is approximately the total cost divided by the total number of acres under cultivation on the farm. If a tractor is used for any operation, a separate charge should be made for this item. The usual prices charged in custom thrashing have been used; this covers all costs for the use of machinery in this operation. The use of the automobile is of undoubted benefit to the farm business on the average farm; however, the automobile is used to a considerable extent for pleasure purposes, and although a number of farmers were found who were willing to make an estimate of the benefit that the car is to the farm business, not enough data are available to justify presenting figures in this connection.

Under the item "Thrashing, per bushel" two figures are given for each crop, the first in each case being the average charge for the period 1911–1916, and the second, the 1917 charge.

Since manure is utilized on many farms, a charge should be made against the crops for this fertilizer. It has previously been pointed out that, on the average, approximately 30 acres are covered with manure each year on the farm of 640 acres. Assuming an annual application of approximately 10 tons per acre, this application is equivalent to 0.65 tons per crop acre. This distribution of the charge is justified, inasmuch as the benefits from the manure accrue for several years after application and the object is eventually to cover the whole farm.

COSTS FOR 1917 AS COMPARED WITH PREWAR COSTS.

In Table IX are shown the relative costs of the various items entering into farm operation for the period 1911-1916 and for 1917, on a representative farm having a total acreage of approximately 640, with an organization and equipment that approaches the average very closely.

It will be noted that there is an increase in the cost of every item, the increases being particularly noticeable in the case of seed for planting and in the value of machinery. The cost of "Labor per productive day of work" is determined by ascertaining the total cost of all hired labor by the day or month, together with the labor done by the family at average rates, and dividing the sum of these by the total number of days of productive work done per farm per year. By productive work is meant that which is applied directly to an enterprise such as wheat production or stock raising, etc. All other labor, such as that necessary for the general upkeep of the farm, is considered as overhead expense, and is paid for in the labor by the day or month, or is pro-rated to the various productive enterprises. The increase noted in the cost of a productive day's work corresponds to the increase in the cost of labor by the day or month as indicated.

The increase in the value of farm machinery is 40 per cent, but additional information (1918) indicates that even greater advances have been made.

Concerning work stock, feed costs are the only costs that have advanced recently, so that depreciation in work stock may be considered as indicated on page 15. The difference in annual cost of work stock between $105 and $145 represents the increased cost of feed.

Table I.—Cost of various factors entering into cost of production of crops on a representative farm in North Dakota for 1911–1916 and for 1917.

Factors entering into cost of production.	Cost 1911-1916.	Cost 1917.	Factors entering into cost of production.	Cost 1911-1916.	Cost 1917.
Seed cost (per bushel):			New value of machinery [a]	1,757.00	2,473.00
Wheat	$1.23	$2.28	Feed for work stock:		
Oats	.47	.70	Oats, per bushel	.39	.61
Barley	.72	1.19	Hay, per ton	6.65	9.77
Flax	2.23	3.36	Manure, per ton	1.00	2.00
Hired labor:			Thrashing, (per bushel):		
Per month	35.00	45.00	Wheat	.10	.145
Per day	2.44	3.16	Oats	.06	.087
Labor per productive day of work	2.20	2.83	Barley	.06	.094
			Flax	.20	.35
Farm cost of board per month	15.70	22.80	Twine, per pound	.118	.18
Farm cost of board per productive day	.89	1.29			

[a] Does not include tractors, thrashing rigs, or automobiles.

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